Microbial Fossilization Processes in Alkaline Hot-springs, with Implications for Astrobiological Exploration of the early Earth and Mars

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Hydrothermal environments were widespread on the early Earth and likely to have been important sites for early biosphere evolution. Hydrothermal systems could have also provided habitable surface environments on Mars early in that planet's history and could yet be present in the subsurface there. Ancient hydrothermal deposits are regarded as high priority targets for future missions to Mars explore for fossil biosignatures. But what biological information is actually preserved in hydrothermal deposits and what potential do they hold as long-term repositories for a microbial fossil record? Answers to these questions hold important implications for deciphering the earliest fossil record on Earth and for refining future strategies to explore for Martian life. Modern terrestrial hot-springs provide excellent an opportunity for in situ investigations of a wide variety of microbe-mineral interactions, many of which are considered fundamental for understanding the basic processes of microbial fossilization. In this talk I will review the various biological, chemical and physical factors that control microbial biosignature capture and preservation in modern alkaline hot-springs of Yellowstone National Park. Comparative studies of well-preserved, ancient analogs (Plio-Pleistocene travertine deposits of Furnace Creek, Death Valley and Devonian siliceous sinters of NE Queensland, Australia) will provide a framework for considering of the impact of early diagenetic processes (e.g. mineral phase changes, infilling and cementation of porous sinter frameworks and coarsening during recrystallization) on long-term biosignature retention. An important conclusion is that although organic matter preservation tends to be restricted to the low temperature facies of alkaline hot-spring deposits, recurring associations of microscale biofabrics and mesoscale biosedimentary structures are commonly preserved, even in deposits that have undergone substantial diagenesis.